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HYDRA I DATA DISPLAY SYSTEM

by Roger L. Hodgkins and Donald R. Osgood

Manned Spacecraft Center
Houston, Texas

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ABSTRACT

The Hydra I is an extremely flexible and versatile data display system in which a television monitor screen serves as a working surface upon which an operator can develop, or create, graphic displays such as written documents, charts, diagrams, graphs, background slides, and other graphic art through the use of special control keyboards and operating techniques. An operator can create, rearrange, delete, or add to the graphic display to develop any desired format. Upon completion of a graphic display, it can be recorded in a magnetic-tape library, plotted on an X-Y plotter, recorded as a punched paper tape, or recorded as a frame of a sequential-playback magnetic tape. Displays recorded in the magnetic-tape library can be recalled for examination or revision.

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SUMMARY

This document outlines and describes the Hydra I data display system and the components, functional qualities, and various operational techniques for the purpose of disclosing the technical potential of the control concepts embodied in the system. The Hydra I uses a television monitor screen as a working surface upon which an operator can develop, or create, graphic displays such as written documents, charts, diagrams, background slides, and other graphic art. The graphic display can be recorded in a magnetic-tape library, plotted on an X-Y plotter, recorded as a punched paper tape, or recorded as a frame of a sequential-playback magnetic tape. The concepts incorporated into the Hydra I system are of lasting interest to the information system designer.

INTRODUCTION

The Hydra I data display system[1] was one of four display processing projects originally considered by the Data Systems Development Branch of the Information Systems Division (ISD) of the NASA Manned Spacecraft Center. The Hydra I was chosen for development to the exclusion of the other three systems because it could fill such a wide variety of definite needs. It could serve as a developmental study into computer-aided graphical generation and associated graphical-data problems. Of special interest were operating controls, tutorial dialog between the computer and the human operator, and the storage and retrieval of graphical displays developed on a volatile medium such as television. After the basic hardware had been fabricated and assembled, programs were developed incorporating the design philosophy worked out in preliminary studies and several earlier automatic checkout systems. It was at this point that the Hydra I concepts first began to verify the conclusions of the preliminary design studies. The system was used to assist the analysts in programing. The online programing sections of the system were developed first, and the keyboard-controlled and display-oriented

[1]In Greek mythology, Hydra was a serpentine monster with many heads. When one of the heads was severed from its body, it grew two heads to replace the lost one. The name is particularly apt. Even when discontinued, the Hydra I system had already been transferred to two other computer-display systems. The current Hydra has more "heads" than the original.

utility programs were responsible for a greatly reduced effort in developing the remainder of the system. Entire programs can be developed using the Hydra I concept of system bootstrapping, system macrolinkages, and video displays.

The concepts developed for the Hydra I system are currently incorporated in the Hydra II system using advanced control stations, a larger computer, and a digital display system. Documentation concepts developed in the Hydra I system are used in the Loki documentation preparation system.

SYSTEM DESCRIPTION

The display development console (DDC) of the Hydra I data display system is shown in figure 1. The console is used to control and coordinate the two major functions of the system: display development and online programing. In figure 1, the console is being used for display development. The display on the right monitor has been produced using the DDC keyboard. The monitor on the left is a status indicator which is used to instruct the system operator at each stage of display development.

The monitor screen on the right is fundamentally the equivalent of a blank sheet of paper, a flat working surface upon which displays are developed. By manipulating the keyboard and other input devices, an operator can cause material (such as written or printed copy, charts, tables, diagrams, graphs, background slides, pictures, and graphic art in general) to appear on the screen. An operator can rearrange, delete, or add material to develop the desired format; and upon completing a display, the material can be recorded on magnetic tape for recall at will for reference and can be edited, revised, or reviewed as desired. Displays can also be reproduced using an X-Y plotter to produce inked drawings or scribed Mylar masters suitable for photoreproduction. Figures 2 and 3 show a typical programing operation involving an examination and change of contents of words in computer memory.

Figure 4(a) is a block diagram showing the basic configuration of the Hydra I system. The units which make up the input and output systems have been arranged in a column on the left side of the page. The division between the two systems is indicated by a dotted line, with input units shown above and output units shown below the dotted line. Figure 4(b) is a diagram of the digital graphic subsystem.

There are four groups of equipment in the Hydra I: the input and control equipment, the Univac 1218 computer (fig. 5) (Sperry-Rand Corporation, Univac Division Electronic Data Processing and Tabulating Equipment, New York, New York), display-output equipment, and hardcopy-output equipment. These groups are described in the following paragraphs.

Input and Control Equipment

There are two types of input units: information units (fig. 6) and control units (figs. 6 and 7). The information units are the alphanumeric keyboard which introduces printed and pictorial material into the system and the punched-paper-tape reader. Control units instruct the system and include the strobe-control keyboard, the function-switch bank, and the Charactron unit (fig. 7), Stromberg-Carlson Corporation, Data Products Division, San Diego, California.

Alphanumeric keyboard. - The alphanumeric keyboard (fig. 6(b)) is configured as a conventional typewriter keyboard with 65 separate characters, numerals, and symbols. However, a delete key gives the Hydra I alphanumeric keyboard a significant advantage over a conventional typewriter. Any error typed onto the monitor screen can be erased completely, quickly, and automatically.

The alphanumeric keyboard also has several special keys used for special symbols, greek characters, program control, and magnetic-tape recording control. In addition, certain strobe-control keys associated with the typing mode of operation appear on the alphanumeric keyboard as well as on the main strobe-control keyboard. The shift bar, the backspace key, and the keys marked with directed vertical arrows are strobe controls. Essentially, these strobe-control keys function to imitate the action of the conventional typewriter carriage on the monitor screen.

Alphanumeric data may be entered on the display monitor in either of two ways: in the typewriting mode in which characters appear on the monitor screen as they do on a typewriter carriage, and in the random mode in which characters can be positioned at random. These features are particularly useful in labeling pictorial displays.

Strobe-control keyboard. - The main strobe-control keyboard is located on the right of the control panel (fig. 6 (a)). There are two strobes: the diamond strobe and the star strobe. The keys on the right of the strobe-control keyboard operate the diamond strobe. The star strobe-control keys, identical to those of the diamond strobe, are located on the left of the keyboard. Operations which require that both strobes be brought into play are controlled with the single column of keys between the independent strobe controls.

To understand the operation of the strobes, imagine an exceedingly fine gridwork, such as the background of a graph, superimposed on the face of the display-development monitor. Each intersection of a horizontal and vertical line on this grid defines a fixed point. The two strobes are movable points which appear on the monitor screen as a star and as a diamond. By manipulating the strobe-control keys, the Hydra I operator can cause the star or the diamond to move along the grid. The strobe moves horizontally or vertically in discrete steps from one fixed point to another. The keys which control the motions of a strobe are arranged as crosses on the strobe-control keyboard. Up, down, right, or left directional movement is produced on a strobe by depressing the key on which a labeled arrow indicates the desired direction. The strobe is moved step by step, but it will always start and stop on some fixed point. When a strobe is used in conjunction with the alphanumeric keyboard, the strobe is shifted automatically from each letter position to the next adjacent letter position during the typing process.

One strobe is required as a position indicator for the typing mode, but two strobes are required to establish the end points for the drawing of lines. If the operator wishes to underscore a printed sentence, he would position the star strobe at one end of the sentence at an appropriate vertical distance beneath the print, then aline the diamond strobe at the opposite end on the same vertical level. One of the three keys located between the strobe motion controls would then be touched. The top key draws a solid line, the middle key draws a dashed line, and the bottom key draws a dotted line. The lines are drawn automatically between the selected strobe end points. If the operator wants to draw another line exactly parallel with the first, he can interlock the strobes, then move them together to the desired position of the second line. At the new position, he once again depresses the line-drawing-function key. This operation is useful for making graphs and forms. However, the lines need not be horizontal or vertical; they may be drawn at any angle from any point to any other point. The system status-display monitor provides the operator with a list of strobe coordinates and with all information necessary for the development of a display. A typical status display is shown in figure 8.

Function-switch bank. - The function-switch bank is located on the left of the control panel (fig. 6(a)). There are four rotary switches and 24 keys. Three of the four rotary switches are presently active, and they control the rate of strobe movement, select programs, and determine the size of print which appears on the screen. The first row of function switches contains four keys, each positioned directly beneath a rotary switch. An action selected by the rotary switch is initiated by the key which corresponds to that switch.

In the two lower rows of switches, there are keys which perform the following functions:

1. The Hodgkins utility-package (HUP) key enters a special program package, which may be used for online program modifications.

2. The key marked PLIB brings the program library into the system.

3. The key marked CLEAR removes a display from the display development monitor.

4. The four switches in the second row marked M1, M2, M3, and M4 correspond to the four keys immediately below marked D1, D2, D3, and D4.

This block of eight keys may be used by the operator to select which monitor will be used as an output for a particular display channel.

Charactron unit. - A cathode-ray tube, known as a Charactron tube, is used to project alphanumeric characters and lines in the display system. The face of this tube is scanned with a television camera, and the camera output drives the monitors on the DDC. The Charactron tube is shown mounted in a logic rack (fig. 7). In addition to the television camera, a 35-mm camera is provided to photograph a monitor-tube face, thus producing rough copies of displays when desired.

Univac 1218 Computer

The information and control signals from the alphanumeric keyboard, the strobe controls, and the function-switch bank are sent to the Univac 1218 computer (fig. 5) which generates the display and transfers it to the digital-to-television conversion display system (D/TV). The D/TV unit is shown in figure 9. In the D/TV system, the data from the computer are converted to a form suitable for the operation of the television monitors on the console. Figure 10 is a closeup view of the interface unit of the D/TV display system.

Display-output equipment. - The two video monitors, which are the primary-output devices, are located on the display-development console. They are driven by two channels of D/TV display. The X-Y plotter monitors are an integral part of the Hydra I system. Both monitors (the tutorial and the display-development screen monitors) are in continuous operation during the development of a display.

Hardcopy-output equipment. - The hardcopy-output equipment is the recording equipment to be used after the display is built up and copied or stored on magnetic tape. The secondary-output units, in contrast to primary units, are not usually used until a display is fully developed and edited. The secondary-output units are directly connected to the computer in the case of magnetic-tape units and the Calcomp X-Y plotter (California Computer Products Incorporated, Anaheim, California), and are linked indirectly through punched paper tape in the case of the Gerber X-Y plotter (Gerber Scientific Instruments, South Windsor, Connecticut).

Magnetic-tape units. - The magnetic-tape units are used to hold a library of stored displays. These displays may be recalled to the display-development monitor for examination, editing, or output.

Calcomp X-Y plotter. - The Calcomp X-Y plotter is used to draw the display on paper just as it appears on the display-development monitor. To obtain a working copy of a display which has been stored on magnetic tape, an operator must recall the display from the display library to the display-development monitor. The operator then depresses the Calcomp output function key to initiate the output process. The output of the Calcomp plotter is of limited quality and is used as a rough draft of the display graphic. A Calcomp copy of a typical Mission Planning and Analysis Division (MPAD) slide is shown in figure 1.

Gerber X-Y plotter. - The Gerber X-Y plotter can be used to produce high quality graphics. The Gerber plotter can produce inked drawings for photographic contact printing. The letters which the plotter draws on the masters need not reflect the style of letters which appear on the display-development monitor. Special programed type fonts can be developed which will guide the Gerber plotter in producing virtually any style of print.

OPERATIONAL PROCEDURES

To assist an individual who is attempting to correlate the various elements of the Hydra I system, a fairly complex example will be followed through to completion as an operator might develop the display on the console.

Assume, for example, that a graph is required with labeled X- and Y-axes, scales, and several labeled curves. The hypothetical graph is to show the variation of gas pressure measured at some point, varying with time after the opening of a valve.

Other valves are then substituted into the system with each valve generating a separate pressure versus time curve. The Hydra I operator would need only a list of the empirical results of such an experiment to construct the graph.

The first production requirement, in this case, is the background grid of the graph which can be readily drawn using the strobe controls. The two strobes (indicated by a star and a diamond) are locked into relative position. With the strobes locked, the touching of the direction key indicating UP, for instance, would result in both the star and diamond moving up. A line drawn between the two strobes, accomplished by touching the proper line key, can then be generated at any position on the screen. In drawing the parallel lines which make up the background grid of the graph, the operator might follow this sequence of control:

1. The star and the diamond would be alined on the same vertical level on the screen at a measured distance apart.

2. The alinement is checked against the list of strobe coordinates on the status display monitor.

3. When in the desired relation, the top line-drawing key on the strobe control keyboard would be touched making the lowest line of the graph appear on the screen.

4. The strobes would be locked and, using one or the other of the direction keys, both strobes would be moved up a measured number of vertical increments.

5. Another line would be drawn at this point which would exactly and automatically parallel the first line.

6. This method would be very rapid, with pauses only to move the strobes the required number of vertical increments after the drawing of each line, until all of the horizontal lines of the gridwork are completed.

7. The strobes would then be unlocked, alined again in a vertical plane, and locked once again to complete the vertical lines of the gridwork.

8. Graph lines are drawn in over the completed gridwork by using the two strobes as alternate data points.

9. Labels and legends on the display can be accomplished by using the facilities of the alphanumeric keyboard to complete the production.

Figures 11(a) and 11(b) show examples of various steps in graphic development produced on the Hydra I. The hydra and chessman symbols were produced by single keys on the alphanumeric keyboard, as though they were alphanumeric characters.

The procedure described is an outline of one method of producing a graphic display on the monitor screen of the Hydra I using the fully automatic parameters to accomplish the desired results. There is no limit to the number of types of graphic displays which could be produced by an adept operator using this method alone. The functions of all the numerous input controls and components incorporated into the present Hydra I system were analyzed in an attempt to define limitations of the unit as a whole. Operational specialists and experimental efforts have already disclosed that practically any reproducible material or data can be composed, edited, rearranged, and transferred to or duplicated on the monitor screen of the Hydra I.

POTENTIAL APPLICATIONS

Several areas are suggested in which the Hydra I system could be particularly useful. This is not meant to imply that the system is fully implemented in any of the areas, but rather to suggest directions which users might follow in accordance with requirements. Once the requirements are established, the Hydra I development group can adapt the system to particular needs.

Management Support

The Hydra I can be very useful in providing management support. Any management operation which requires compilation, storage, and frequent updating of forms (such as accounting processes or supply record keeping) can be streamlined with the Hydra I. Accounts could be set up on the system, stored in mass memory, and recalled for updating, review, or printout. Historical records may be kept readily available for each form filed, displaying the updated changes in the sequence in which they were made. The files could be searched for particular data-summary totals, and reports could be composed automatically and copied using either a line printer or an X-Y plotter.

Another system application which might be of interest to management is the production of briefing charts. These charts may be compiled, stored, and updated quite easily. Complete standard-size charts can be produced using a wide pen or a felt pencil installed in the Gerber X-Y plotter. If a slide presentation is desired, the plotter can scribe viewgraph or overhead projector slides suitable for projection.

Graphic Artwork

General graphic artwork is the forte of Hydra I. The system can be used to set up block diagrams, charts, and overlays annotated with alphanumeric material. Frequently used graphic formats and drafting forms can be stored and displayed. The system is particularly useful for graphics which must be updated frequently. A typical example of graphic artwork produced is shown in figure 12.

Hydra I graphic artwork has been extended into areas of engineering design. Standard logic or electronic symbols, such as the standard integrated-circuit logic symbols, can be programed into the system, and the operator can then create logic or circuit diagrams online.

Mission Planning, Review, and Analysis

The Hydra I system is capable of producing displays based on computer-generated data for trajectory and orbital parameters. These displays can be included in mission planning documentation.

Mission log tapes may be displayed sequentially for postmission review. The activities of the flight controller may be analyzed, and monitoring data may be compiled for study. The system is capable of producing animated displays. An application of this capability is the production of animated bar graphs, each bar representing some parameter which varies with time.

Development of Illustrations for Documents

Hydra I, because of the memory capacity and the typesetting capability, is ideally suited for the development of illustrations for documents using the special control consoles, and mission documentation personnel can develop illustrations and store the pages in individual data files in the display library. A page may be recalled from storage at any time to be updated. The system operator is able to delete or add material at random within an illustration with no laborious retyping of material necessary to accommodate the changes.

The system does well in producing printed documentation, but there is one restriction. Although it is relatively simple to delete material from text and to insert new material in its place, the revision must be made in section blocks of uniform size. As yet, there is no means of opening the stack of print to insert additional text or closing the stack to take up the space left by deleted text.

CONCLUDING REMARKS

There is no limit to the number of types of graphic displays that an adept operator can produce with the Hydra I data display system. The Hydra I system is capable of reproducing written documents, charts, diagrams, background slides, and other graphic arts. The Hydra I has applications in management support; graphic artwork; and mission planning, review, and analysis. Because of the memory capacity and the typesetting capability, the Hydra I system is suited to the development of illustrations for documents. The graphic displays can be recorded in a magnetic-tape library, plotted on an X-Y plotter, recorded on punched paper tape, or recorded as a frame of a sequential-playback magnetic tape. The disadvantage of the Hydra I system is that the revisions must be made in section blocks of uniform size.

Manned Spacecraft Center
National Aeronautics and Space Administration
Houston, Texas, February 9, 1968
921-40-01-00-72

NASA-S-68-958

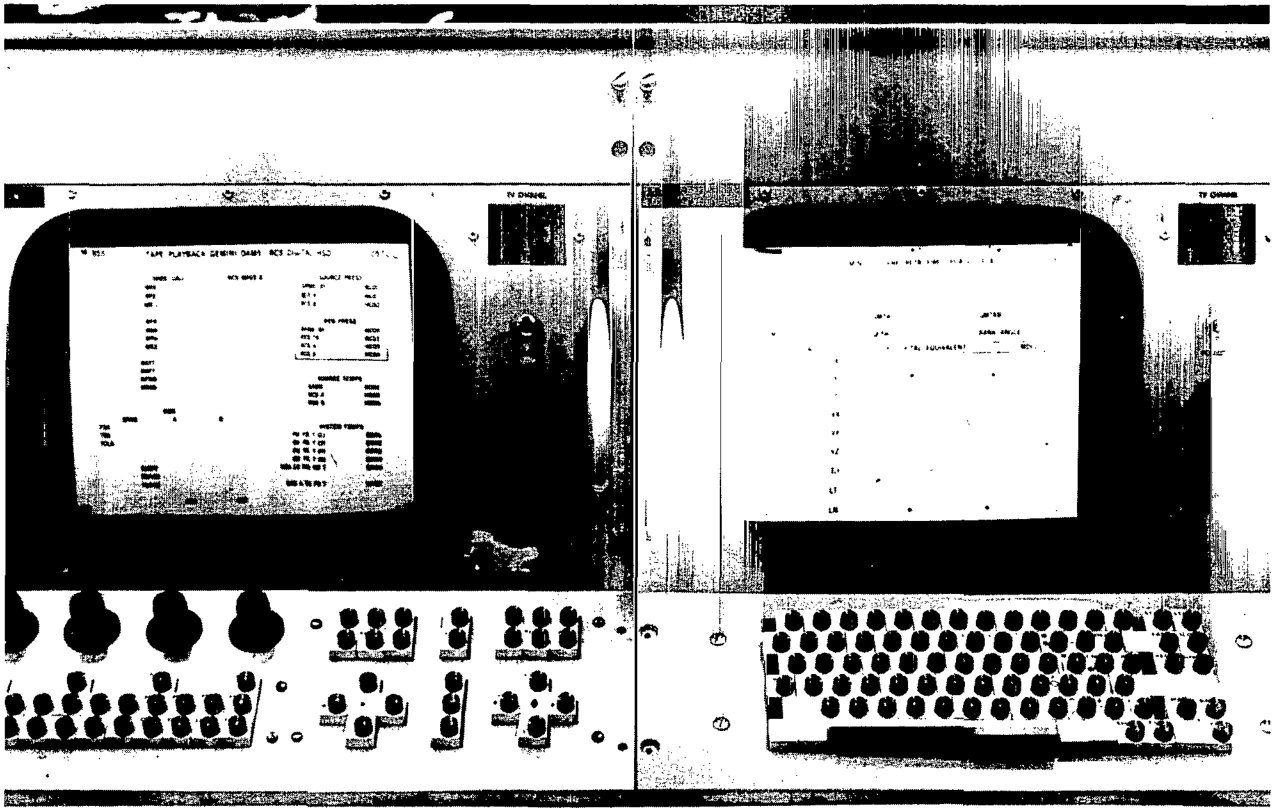

Figure 1. - Data development console.

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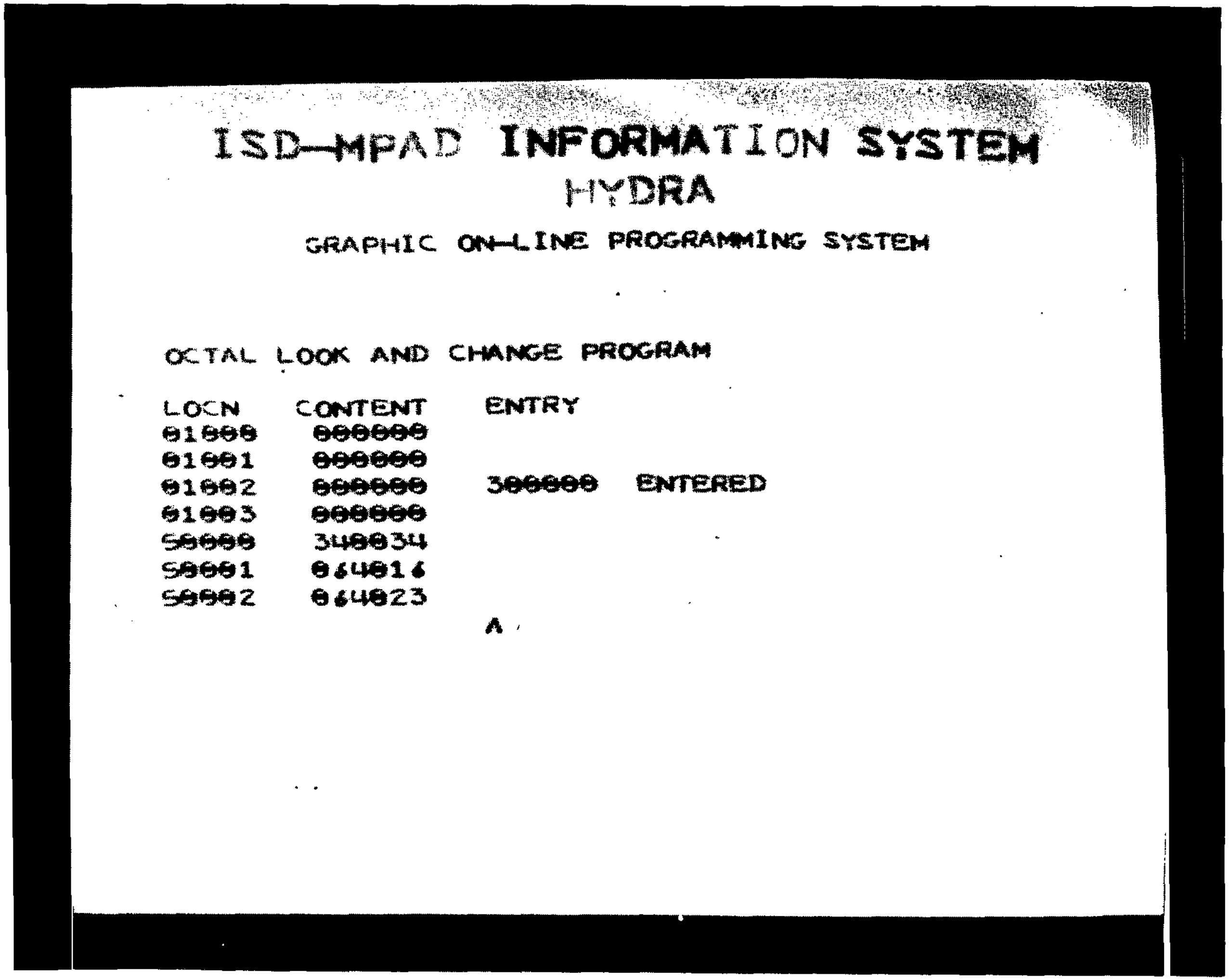

Figure 2. - Look and change program, before change.

NASA-S-68-960

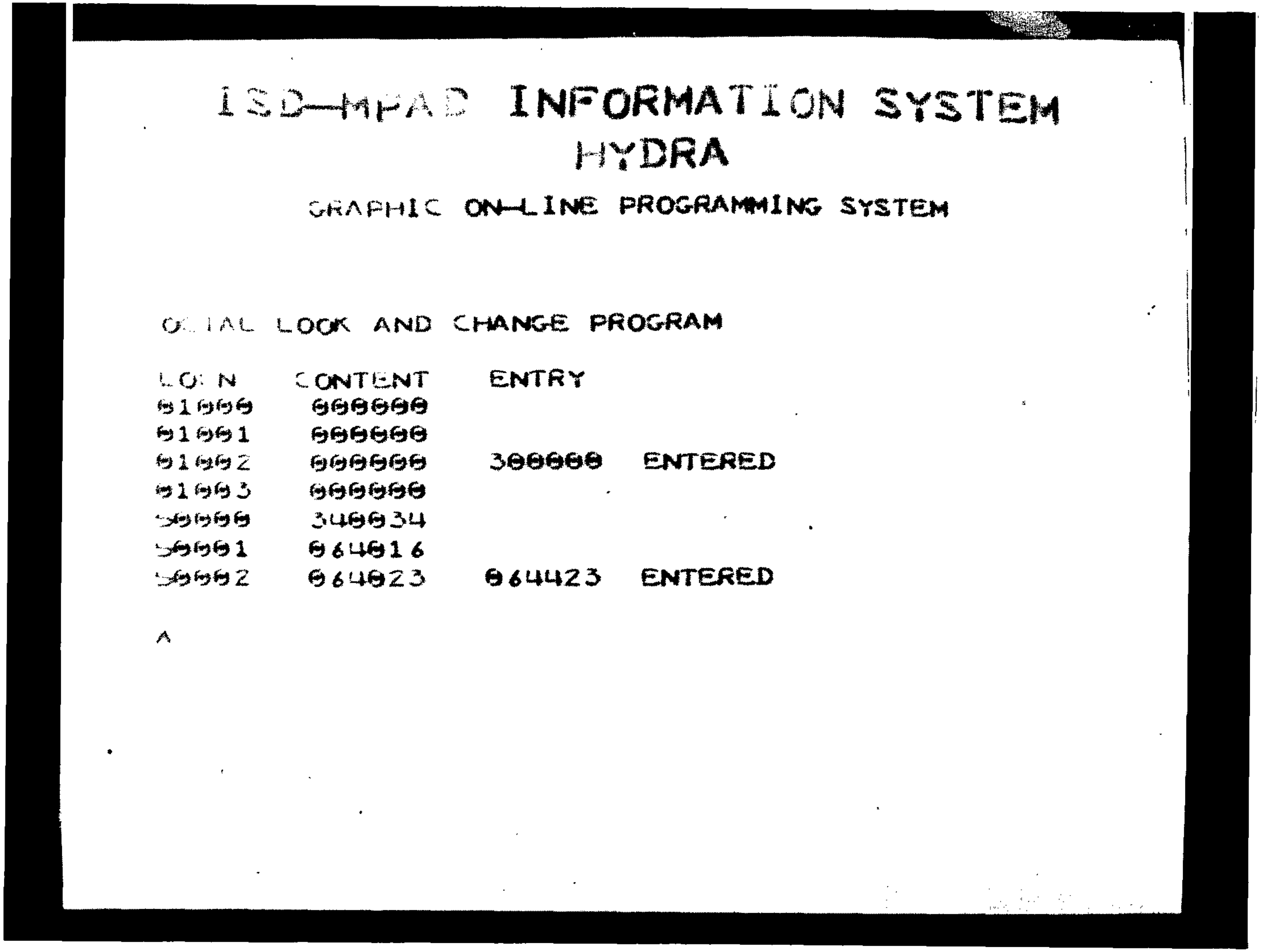

Figure 3. - Look and change program, after change.

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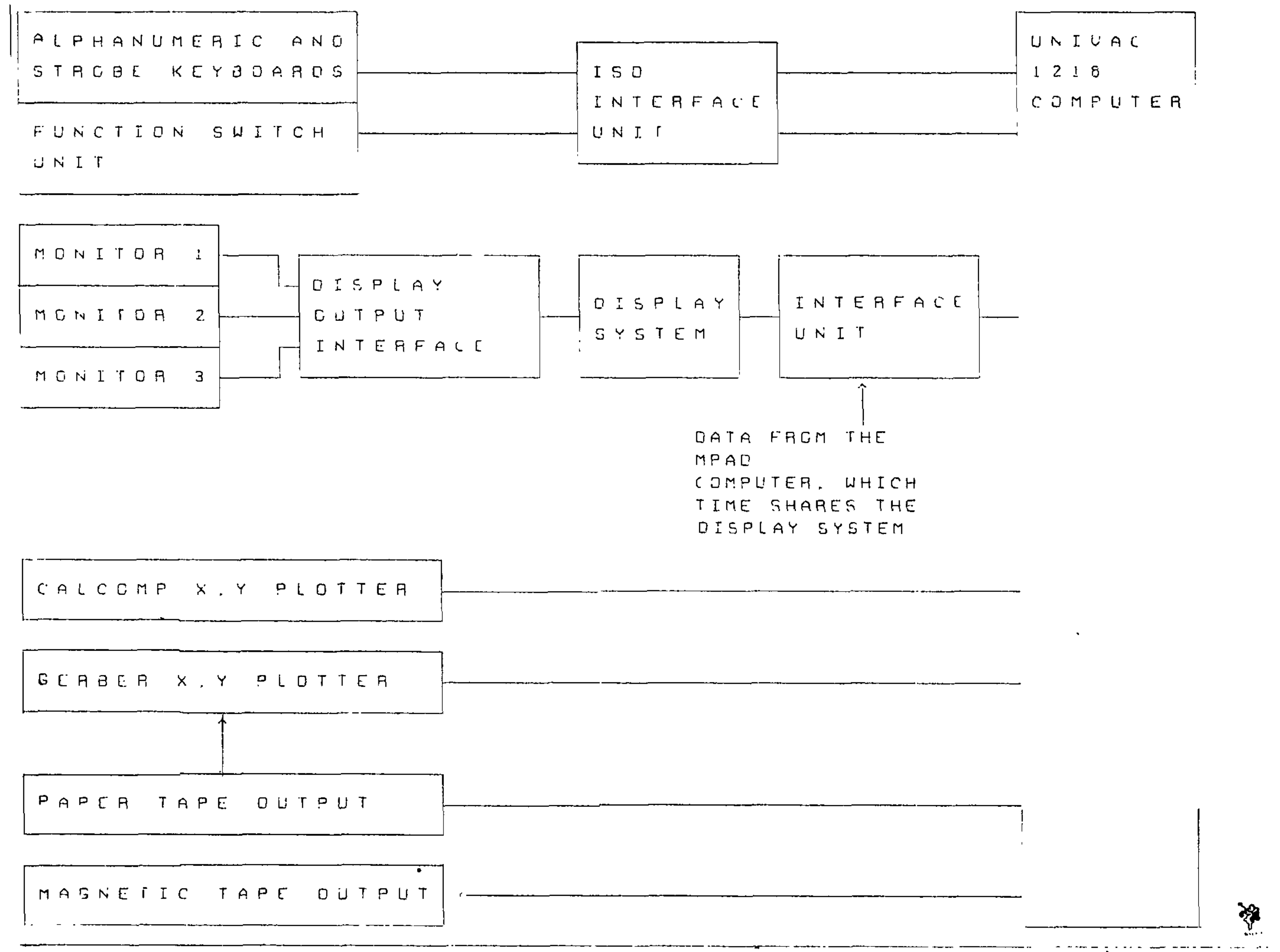
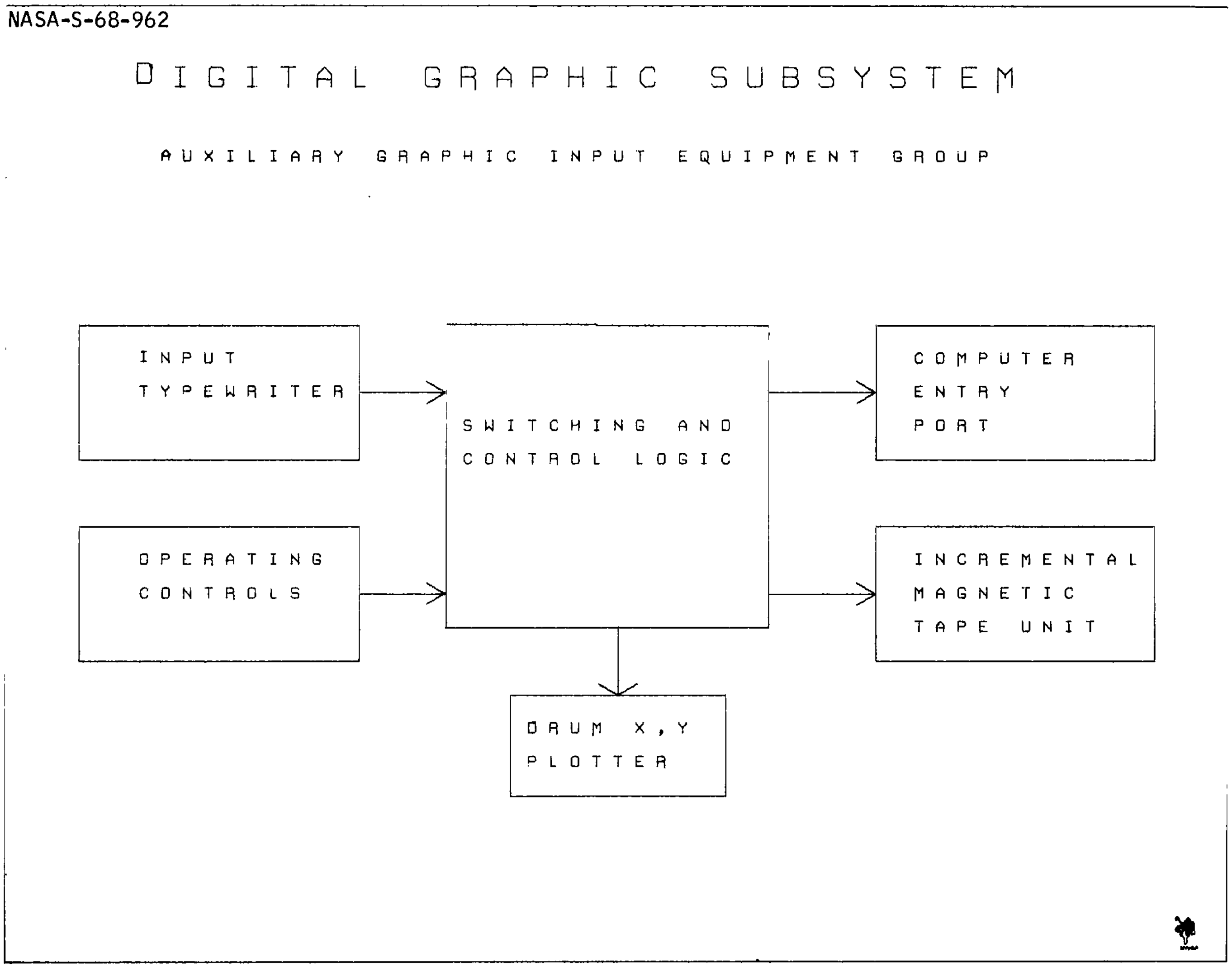


(a) Block diagram.

Figure 4.- Hydra I data display system.



(b) Digital graphic subsystem.

Figure 4. - Concluded.

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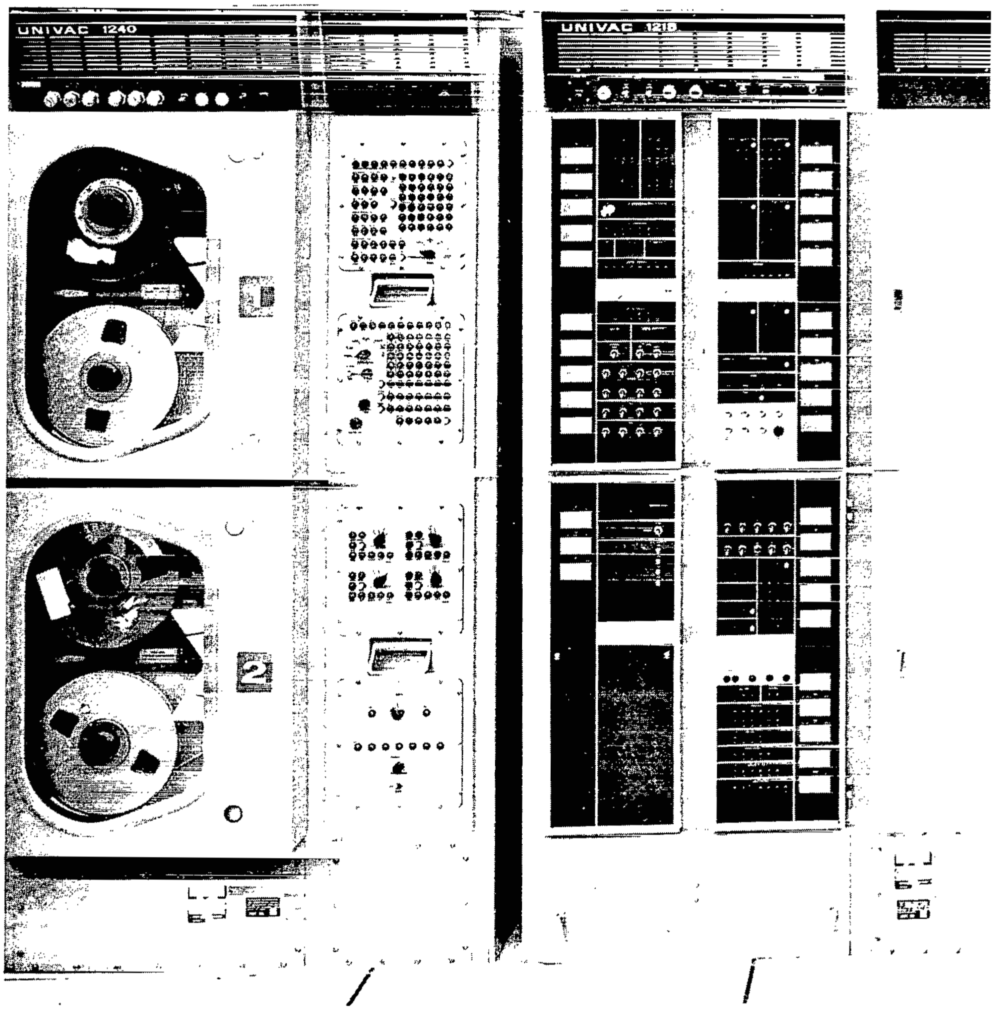

Figure 5. - Univac 1218 computer.

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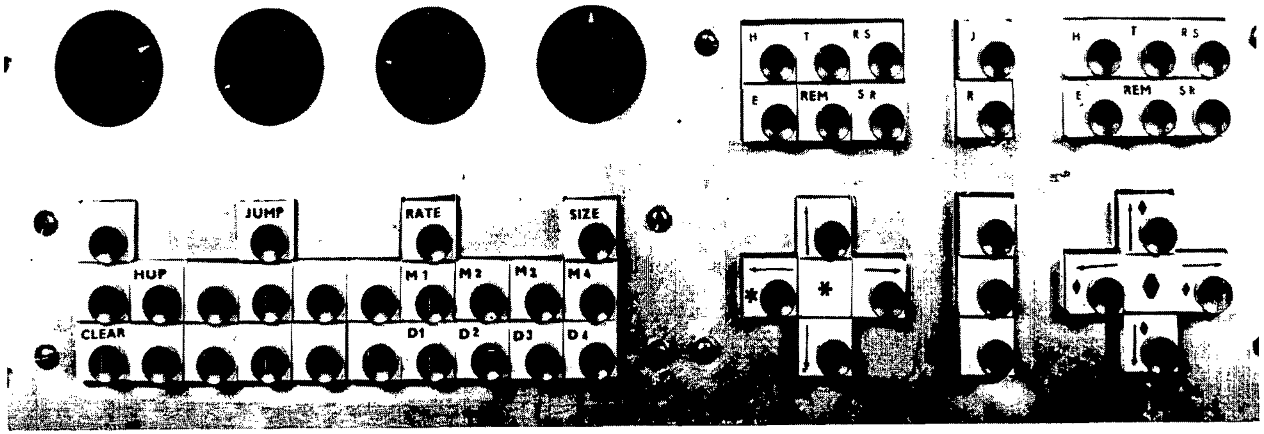
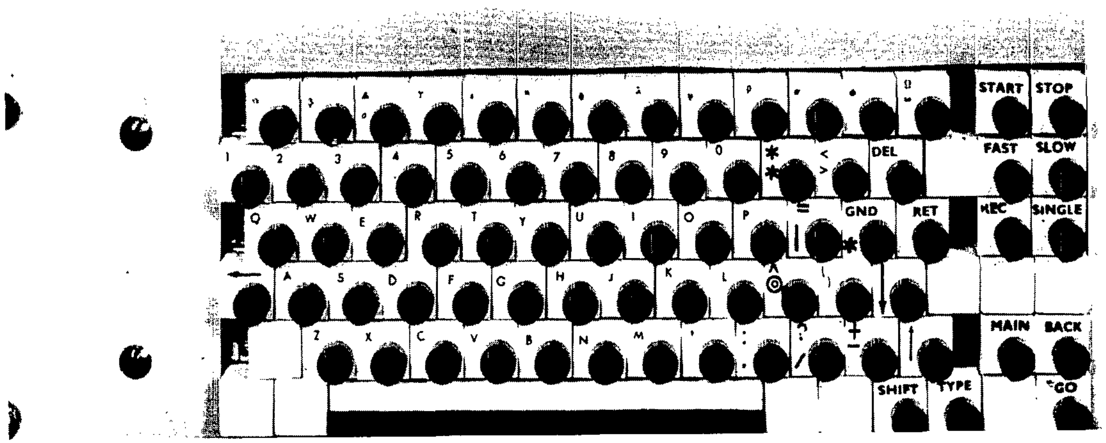


(a) Strobe-control keyboard and function-switch bank.



(b) Alphanumeric keyboard.

Figure 6. - Console control panel.

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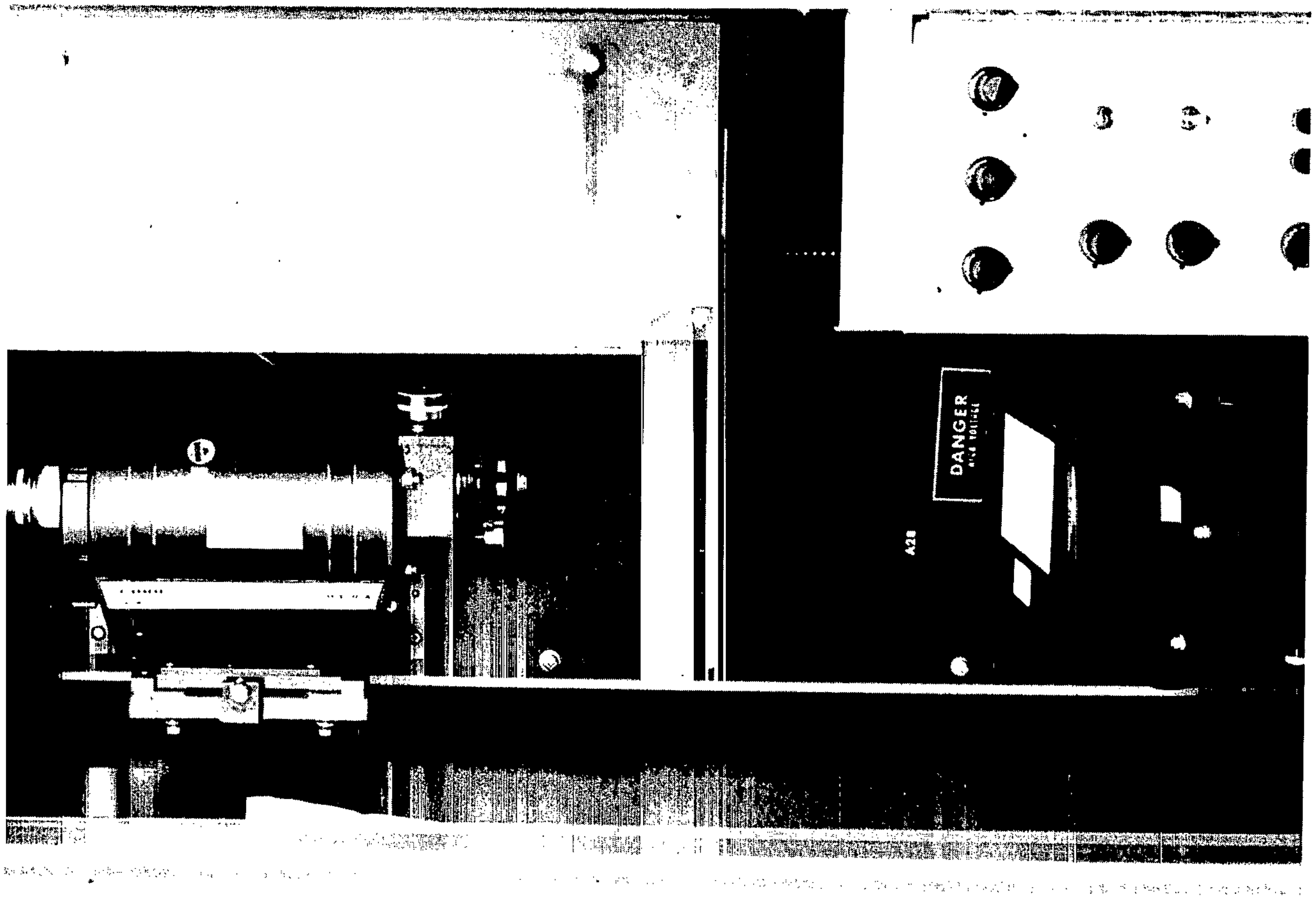

Figure 7. - Charactron unit.

NASA-S-68-964

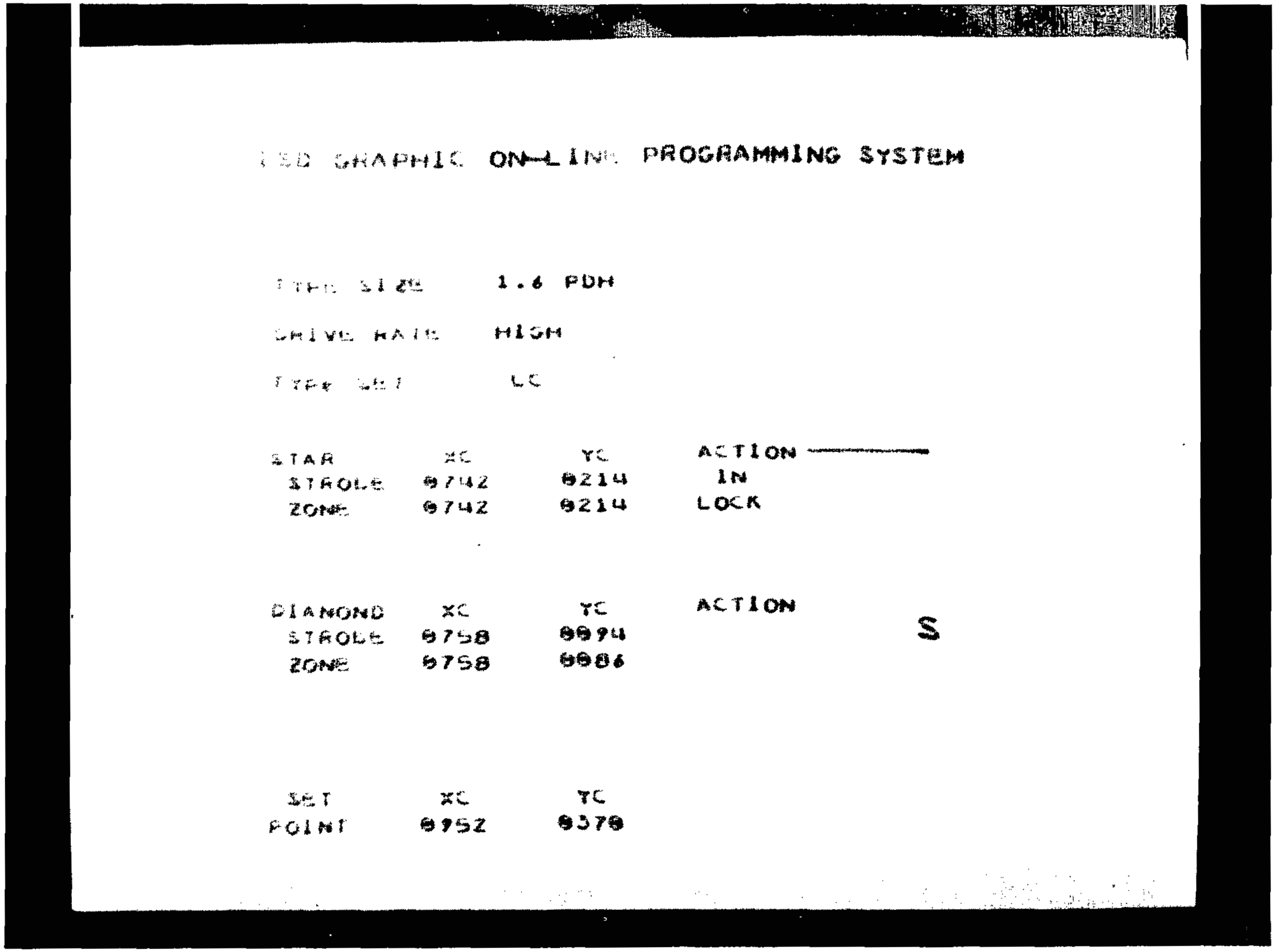

Figure 8. - Status display.

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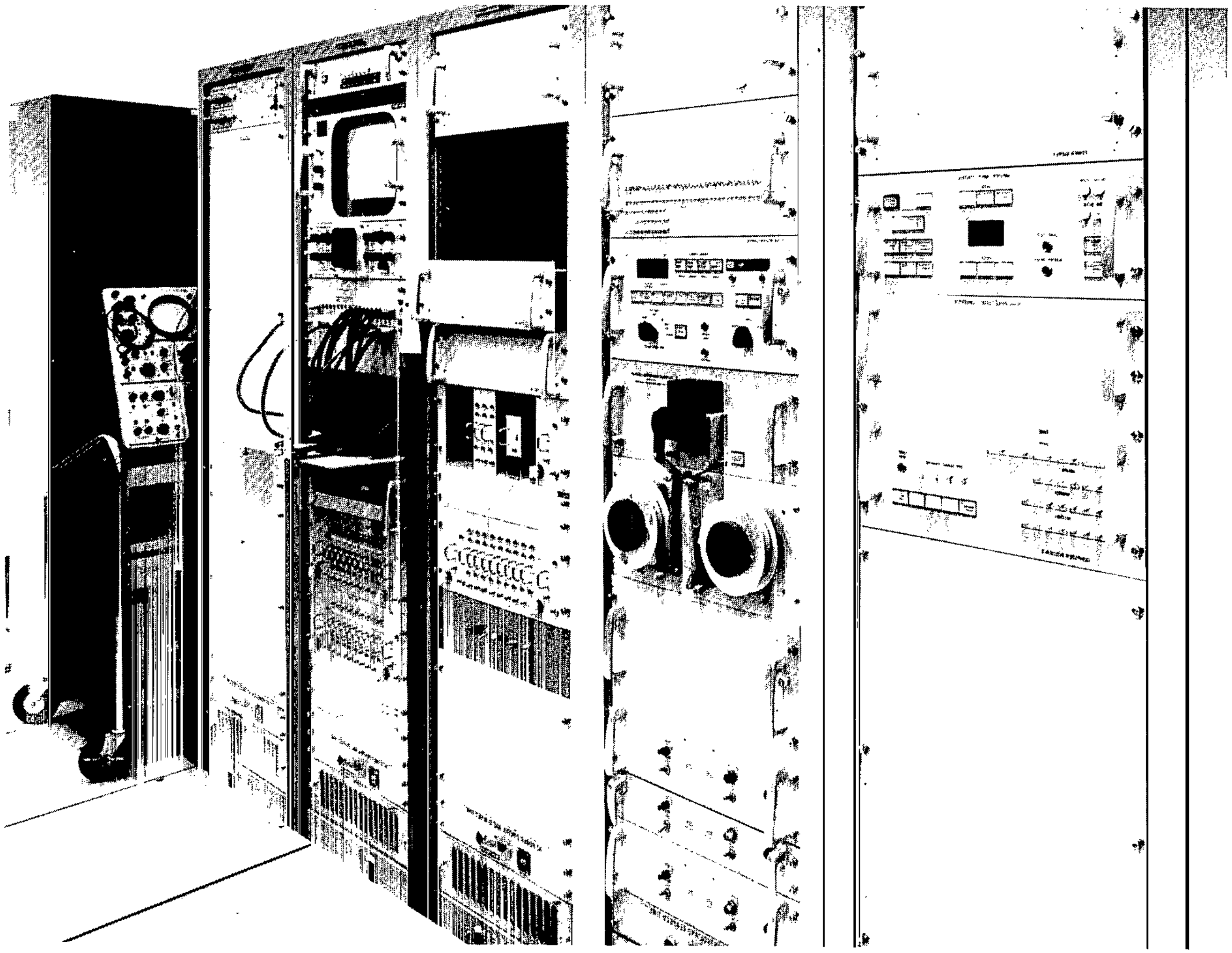

Figure 9. - Digital-to-television conversion display system.

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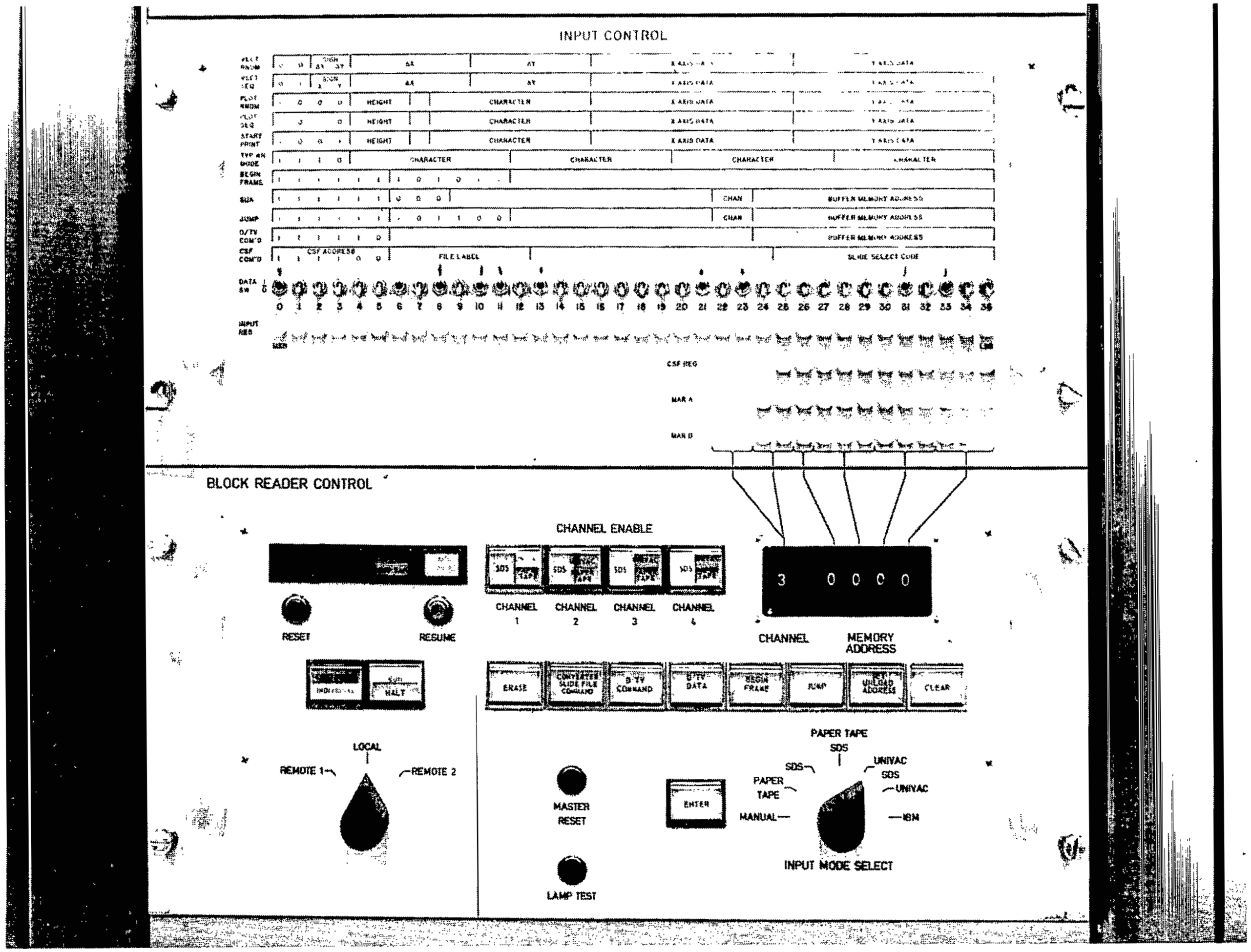

Figure 10. - Interface unit of the digital-to-television conversion display system.

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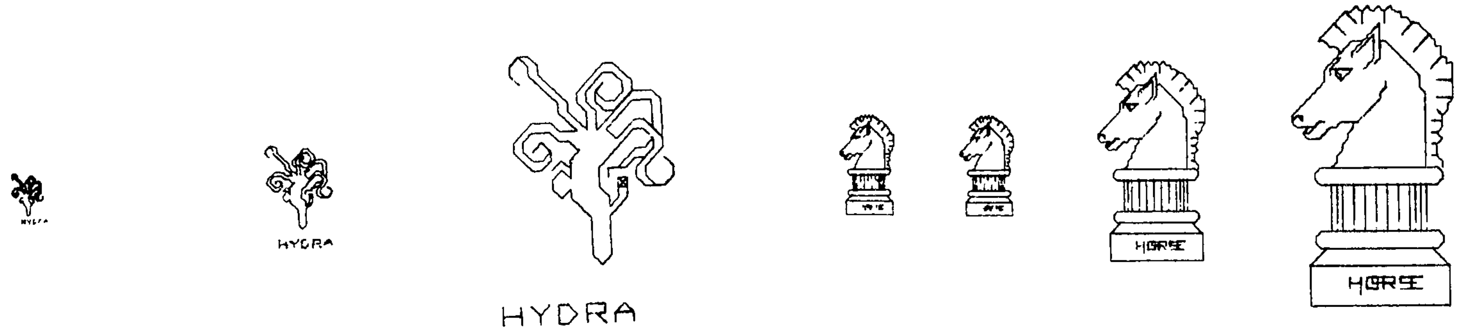

(a) Hydra symbol.

(b) Chessman symbol.

Figure 11. - Hydra I data display system, typical graphic art output.

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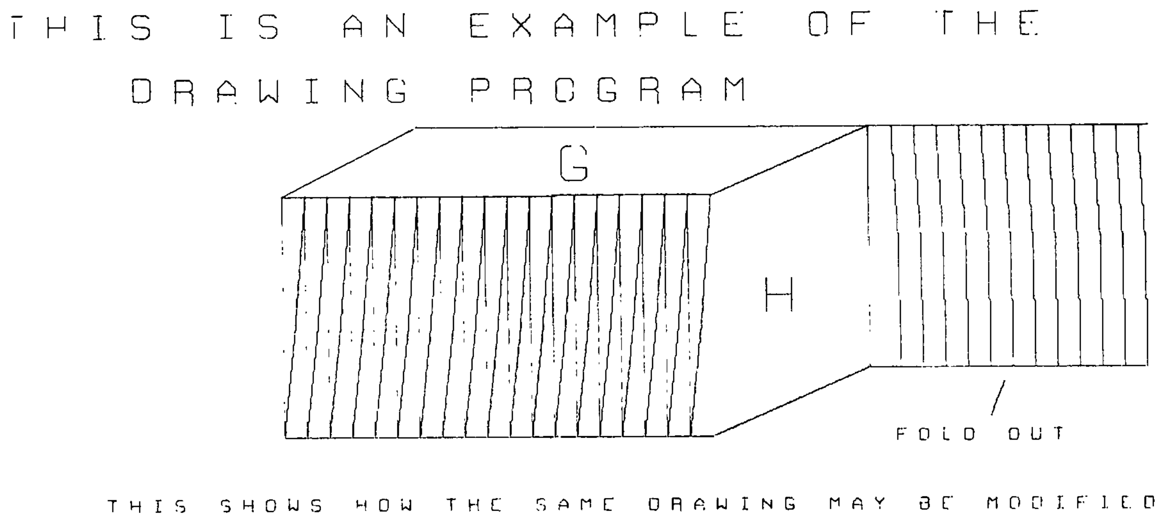

Figure 12. - Hydra I data display system, graphic artwork.

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